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ABSTRACT

The Unified Network of Informatics in Teacher Education (UNITE) is intended to establish a cooperative environment for exchanging ideas and computing resources among school administrators, teachers, interns (student teachers), and teacher educators who are separated by physical distances. A primary objective of the initial phase was to investigate approaches to linking the network's administrative, methodological, and instructional resources. Located in the University of Kansas School of Education, UNITE's hub consists of a primary distribution computer and a local area network tailored for the development of a range of educational resources including those that use CD-ROM and interactive video technologies. The distribution computer is currently linked to Macintosh stations in 16 Kansas schools. HyperCard was selected as the primary development environment for the UNITE software for information retrieval, called the "Resource Navigator." The electronic mail component of the system was used for a three-stage formative evaluation with two Critic SIGs for user feedback, one for making suggestions for the message system and the other for making changes to the Navigator and Resource Catalogs. These messages proved useful in making upgrades to the system software, including the addition of a feature that allows users to enter local materials in the resource catalogs. Electronic networks may serve as useful tools both for gathering evaluations and for conducting rapid modifications to information management systems; however, the development strategies must also consider the social and psychological impact of adjusting the Information Age. The publication of community-based resources that are relevant to user needs and allow educator participation may facilitate acceptance of technological innovations. Examples of three UNITE screens are appended. (48 references) (BBM)

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Global Navigation in the Year 2001

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Near the turn of the 15th century, explorers who faced the unknown beyond their shores were anxiously awaiting the development of effective maps and navigational tools that would guide them safely across the oceans of our planet. As we prepare for the 21st century, the need for a new generation of navigational tools is evident. The quantity and global availability of information is increasing exponentially producing seas of data that are surging in both volume and diversity. For example, "A weekday edition of the *New York Times* contains more information than the average person was likely to come across in a lifetime in the seventeenth-century England (Wurman, 1989 p.6)."

These undulating waves of information content are being transformed further by rapid alterations in form. A myriad of display media, from video style newspapers to holographic arcade games, are emerging to convey information in new forms of animated diagrams, full motion video, "surround" sound and seemingly endless textual combinations of fonts, sizes, styles and orientations. Saul Wurman (1989) and others (Toffler 1970; Naisbitt, 1982) are concerned that instead of contributing to an era of enlightenment, this overabundance may result in mass afflictions of information anxiety and knowledge starvation. The greatest damage may come from being slow in responding to conspicuous need. Thus, the development of effective information management and consumption techniques will require some adjustments in the way we approach research designed to promote rapid development.

This paper is a report of the formative evaluation, insights and resulting modifications that have evolved during the initial phase of developing the Unified Network of Informatics in Teacher Education (UNITE). The objective is not to provide definitive data indicating that method A is more appropriate than method B. Rather, the intent is to participate in exchanging ideas for conducting research and developing information management tools that might lead to more effective strategies for benefiting from the vast array of information and media that we are facing as we prepare to enter the next century.

The Unified Network of Informatics for Teacher Education (UNITE)

The 1986 Holmes Group report explained that comprehensive approaches for integrating technology and education are needed to improve communication and collaboration among educators. UNITE was developed, with support from an Apple Corporation grant, to address the challenge of establishing a cooperative environment for exchanging ideas and computing resources among educators who have common goals but are separated by physical distances. Four constituent groups involved in the Teacher Education program are targeted: school administrators, teachers, interns (student teachers) and teacher educators. A primary objective is to investigate approaches to linking the network's administrative, methodological and instructional resources in ways that best reveal similarities among goals and ultimately foster a team spirit between the constituencies.

UNITE's hub is located in the Instructional Technology Center (ITC) at the University of Kansas School of Education. The hub consists of a primary distribution computer and a local area network tailored for the development of a range of educational resources including those that use emerging CD-ROM and interactive video technologies. The Hub's distribution computer uses standard telephone lines to connect to Macintosh stations in sixteen schools from six Kansas school districts serving over 83,000 students. The districts were selected on the basis of previous and projected clinical experience placements with consideration for equivalent grade level and minority representations.

Each station consists of: a Macintosh SE™ 20Meg hard drive, an Apple Modem™ and an ImageWriter II™ printer (Figure 1).

Prior to the beginning of the 1989 school year, the objectives of the project were described to district level administrators in each of the participating districts. These administrators selected schools that they believed would best serve the goals and objectives of the project. They also worked with the principals in the selected schools to identify the liaison team members.

Liaison teams for each school are comprised of four educators who assist ITC staff in integrating UNITE into their school's curriculum. This team consists of an administrator, a teacher facilitator, a librarian/resource coordinator, and a student intern from the School of Education. The liaison teams met with the project representatives to select the most appropriate site within their schools for placing the UNITE stations. Typically, the stations are located in the teachers work area or the school's library.

Initial design of the UNITE system software

During the spring of 1989, the instructional design team met to discuss alternatives for selecting or developing the UNITE software. Several commercially produced communication and navigation software packages were evaluated in terms of their ability to meet the criteria that were established according to the project objectives. The UNITE software was to consist of three primary components: electronic mail, a collection of educational resources and a Resource Navigator designed to serve as a "seamless" window to both the messaging system and the resources. The software must be easy-to-learn and easy-to-use because many of the target users are computer novices. The system must also provide meaningful support that the users would find useful in their daily educational activities.

After determining that existing software packages did not meet the criteria, the instructional design team established a plan for developing the software. The Resource Navigator would be developed first, including curriculum hierarchy for several subject areas. Model resources would then be selected and the links between the navigator and resources would be beta tested by students in the School of Education. Finally, the messaging system would be developed and beta tested. Upon later reflection, one of the best notions to come out of this initial instructional design phase was the decision to distribute the software earlier in beta versions instead of distributing it as a final 1.0 "fixed" version that would have a later release date and be more difficult to alter. The team believed that by doing this the resulting software would not only be more relevant to the needs of the users but it would also give the initial participants in the schools an awareness of participating in the development of the project resulting in a positive sense of ownership.

HyperText approaches to information navigation

A primary concern in developing the Resource Navigator was how to organize and provide access to the large and diverse information resources that were to be available through UNITE. Another issue was how to design an interface that encouraged the users to browse through resources that might be more regularly used by someone from outside their own constituency or content area. This second criteria was based on research of cooperative group learning (Johnson & Johnson, 1984, 1986; Slavin, 1980) which has found that collaboration is more likely when group members have at least a passing awareness of the specialties and resources used by other members of the group. The instructional design team began by turning to existing examples of computer networks and literature on emerging HyperText strategies for accessing information.

Most existing systems used to locate resources available through computer networks (e.g. CompuServe, The Source, Genie and BITNET) are based on a command line interface. Searching for a resource generally begins with entering a user identification code followed by a password. The user is then "logged on" to the network, which means that they have made a connection through standard telephone lines, or possibly some other telecommunications medium, and are "talking to" a host computer at a remote sight. If a

toll is imposed, the toll begins at the beginning of the search and lasts until the search is completed.

Once the user is logged on to the network, a code (sometimes a very cryptic code) is entered on a line that follows a flashing cursor to describe the parameter of the search. For example, to find resources related to the topic *Ecology* one might enter %FS *Ecology* and press the return key. The screen is then cleared and the first list of resources that relate to ecology appear on the screen. This can often be a very exhaustive list and the user must consult several screens to view the entire listing or select from a list of descriptors to further refine the search.

Although this type of searching can be efficient if the user knows exactly what s/he is searching for, the single line "search window" is very narrow and restrictive. Thus, the narrow search window of command line interfaces may limit the kind of "browsing through the stacks" that occurs when looking for a book in a conventional library. Often times this browsing results in locating books or other resources that expand horizons beyond the original intent of the library visit.

One alternative for expanding the likelihood of browsing is to adopt a HyperText approach for searches. Ted Nelson (1965, 1974, 1981, 1982) was the first person to use the term HyperText in reference to a multidimensional electronic notebook which allows users to access text in ways that support their thinking processes. The ideas for Nelson's term can be traced to Vannevar Bush (1945) who described a mechanism called the *memex* as, "A device in which an individual stores his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory." The visionary Douglas Englehardt introduced the first working example of the *memex* and the first mouse 20 years after Bush's description (Englehardt, 1963; Englehardt & Weeks, 1968). Both Bush and Englehardt believed that the human mind operates by association and that information should be presented accordingly. Their ideas have given rise to some more recent information navigation systems such as the *HyperText Abstract Machine (HAM)* (Campbell & Goodman, 1987), *Notecards* developed by a group at Xerox Park (Halasz, 1987) and the authoring environment *HyperCard* developed by Bill Atkinson at Apple Computer.

Development of the Educational Resource Navigator

After reviewing existing computer networks and HyperText literature the team decided to use HyperCard as the primary development environment for the UNITE software. The most recent version (1.0) of the Resource Navigator is represented in Figure 2. Subject areas are represented as buttons along the vertical axis of the screen. These subject categories can be cross-referenced to the support categories shown at the bottom of the screen. A science educator looking for a Computer Based Instruction (CBI) resource to support an ecology lesson would begin by clicking on the *Natural Science* button along the vertical axis and the *courseware* button along the horizontal axis. A window then appears showing the major sub-categories under Natural Sciences and the educator clicks on the biology button to see a second window overlap on the natural science window. The educator then clicks on the ecology button and sees a listing of computer-based courseware that is relevant to teaching about ecology. The user can then click on a resource (in this example a CBI simulation for the Apple II called *Oh Deer*) and see a screen or "card" that provides pertinent information about the *Oh Deer* simulation (Figure 3).

The information available on the resource catalog cards includes: a description of the courseware, objectives, intended grade level, a ratings by UNITE participants, information about the author of the courseware, equipment requirements and ideas for integrating the CBI. Users can also preview Macintosh CBI that is available on their station's hard drive.

Several revisions to the Resource Navigator were made prior to establishing the 1.0 version represented in Figure 2. A primary concern was how to organize and display a large amount of information within the limited screen size so that the users would be encouraged to browse through content areas and support categories. The original design had the navigator screen disappear once the content area was selected. For example, once *Natural Science* and *Courseware* were selected the screen would change so that only a

listing of courseware pertinent to Natural Science was visible. The instructional design team later opted for the overlapping windows approach because they believed that it would encourage users to browse across both content and support categories.

The idea of overlapping windows can be traced to Allan Kay's work in the mid-seventies when he was with Xerox Park. The unique aspect of the UNITE Resource Navigator is that the overlapping windows scroll to the selected item and are fixed so that each time an item is selected it is visible at the top of the previous layer. This produces a layered hierarchy describing the path that the user has followed while at the same time providing visible and direct access to other information hierarchies.

The Resource Navigator is also designed with associative links that facilitate browsing across the support categories. For example, if the science educator viewing the "Oh Deer" card wishes to see a lesson plan that incorporates CBI on ecology, s/he can click on the *Teaching* button. Clicking on the *Research* button provides access to reports on the effectiveness of using CBI in *Science Education*, while clicking on the *Administration* button might provide certification criteria and state objectives for Science Education.

The Electronic Mail Component

All user input and output to the UNITE system occurs off-line. In other words, the information that is seen on the screen is being drawn from the stations hard drive and not from a host computer as is common in other network systems. When users sign on to stations they first see the navigation screen (Figure 2) where they can browse through the Resource Navigator or view mail by clicking on the mail box icon. When the mail box icon is clicked, a list of messages is seen, with the most recently received message appearing at the top of the screen. Once a user selects a message from the mail list, the screen depicted in Figure 3 appears. From this screen the user can continue to browse through messages, elect to write a new message, throw away "trash" messages, return to the Resource Navigator or sign off the system. Users can send messages to other individual users, to all users or to Special Interest Groups (SIGs).

UNITE is a multi-purpose distributed network. The main hub at the ITC is described as level 1, satellite hubs in long distance calling zones are level 2 and the user stations in the school are level 3. Once a message is written it resides only on that station's hard drive until the next connect is made. All computers in the system remain on at all times. The hub is in a continuous loop calling all level 3 stations within the local dialing area and periodically making a long distance call to the level 2 stations. Whenever a connect is made with a station, the hub sends all new messages it has received to that station. This transfer of messages may occur anytime during the day or night when the station is not being used.

Conducting formative evaluation through electronic mail

Formative evaluation has been defined as "a process of systematically trying out instructional materials with learners in order to gather information and data which will be used to revise the materials (Dick, 1977 p. 311)." There is wide acceptance in the education community that formative evaluation is an important step in the instructional design process. Little research has been done, however, on the effectiveness of formative evaluation. The few studies that have been done (Robeck, 1965; Baker, 1970; Komoski, 1974) principally indicate that instructional design which is revised on the basis of formative evaluation has significantly better learning outcomes than the original designs.

The formative evaluation procedures roughly approximated Dick's three stage method for evaluating instructional software. These stages include: one-to-one evaluations (one to three students); small-group evaluations (five to 15 students); and field tests using 20 or more subjects (Golas, 1983).

A continuous loop of evaluation and revision was used during the four evolutions of the "pre-release" system software. The first version of the system (0.6) was evaluated with a one-to-one technique. Suitable revisions were made based on the first round of evaluation and the software was placed on the school stations as version 0.7.

The message system played a critical role in providing feedback during stage two and stage three evaluations of the early (0.7, 0.8, and 0.9) versions of the software. Prior to the

release of version 0.7 two Critic's SIG's were established. One Critic's SIG was used when making suggestions regarding the message system, the other was for suggesting changes to the Navigator and Resource Catalogs. During orientation sessions in the schools, the UNITE staff explained to the liaison teams that the system must eventually be easy-to-learn, easy-to-use and intuitive so that teachers could rapidly obtain available support before class or during their planning period. The importance of the Critic's SIG was explained and participants were encouraged to make forthright and frequent recommendations.

Over 350 messages were sent to the Critics SIGs. They included suggestions: for adding new subject hierarchies, changes in design and placement of icons, procedures for accessing and organizing the mail system, changes to the step-by-step procedure for enrolling new users and revisions to the on-line instructions. The messages from the Critic's SIGs were very useful in making upgrades to the system software. As opposed to the interview sessions, that were also conducted during this phase of evaluation, the Critic's messages seemed to be more direct reflections of user concerns. Possibly this is because the users were allowed to evaluate the systems according to their own schedule and within the environment in which the final system would be used. The Critic's SIGs are readily available whenever the user encounters a problem and wishes to make a comment. For example, when a user comes across a portion of the subject hierarchy within the navigator that is confusing s/he simply clicks the mail box icon, sends a message to the Critic's SIG and then returns to Resource Navigator to continue browsing.

The use of electronic messages during formative evaluation is a practical means of gauging effectiveness across representative samples of a user population that is separated by physical distances. Although the UNITE system is being evaluated in the relatively confined area of eastern Kansas, it could be extended to English speaking populations across the globe and the Critic's SIGs would continue to function to make the system relevant to the needs of an even broader population. The use of Critic's SIG messages also allows the software developers to be more responsive than would be possible using direct observations or face-to-face interviews. The collection of evaluations is more immediate and some programming changes can be made by sending special "system" messages that alter the software residing on the hard drives in the remote sites.

Community-published dynamic resources

One advantage of distributed systems is that all resources are viewed at machine speed and displays are limited only by the local system software. Thus, more sophisticated and easier to use resources with graphical interfaces can be developed. Some of the more well received UNITE resources have been produced in the ITC to support regional educational activities such as a catalog of field trips activities. When several of the Critic's SIG messages referred to an interest in contributing to these resources, the developer responsible for the Field Trip catalog sent a message to all users asking for suggested additions or modifications to the catalog (the message seen in Figure 4 is a response to one of these requests). In our initial solution for adding user contributions to the resources, the suggested changes to the Field Trip catalog were made at one of the computers in the ITC's local area network. A new version of the Field Trip catalog was then manually transferred to the station's hard drives with each update to the system software.

We were especially interested in refining this contribution strategy after reviewing the literature on user participation in technological innovation. Larry Cuban (1986) has provided evidence that teachers will most often resist educational innovation when they believe that the innovation is being pushed on them. Robert Heinich (1984) has found that teachers will go so far as to intentionally sabotage new forms of technology if they feel threatened. However, a recent study that we conducted on *Teacher Attitude Toward Instructional Technology*, (Aust et al., 1989) revealed that teachers were excited about the prospect of being involved in technological innovation provided that they could be involved in shaping the innovation. This was one of reason for releasing the system software in a beta version and the impetus for the development of community-published dynamic resources.

A more recent solution to the problem of how to add user contributions to the resources is represented by the icon of the hand holding the light bulb seen in Figure 2 of the CBI

catalog. When a user wishes to add a record to the catalog of CBI resources s/he clicks on this *contribution* button icon and is given the option of either adding a new record or modifying an existing record. Once the *Add a New Record* option is selected, an entry screen appears and the user is prompted through a step-by-step series of questions for entering the new record. This process is similar, although somewhat more involved, to the procedure used when withdrawing money from a cash machine at a bank. For example, the user is prompted to enter: the title of the CBI, information about the publisher and vendor, the equipment requirements, a description of intended users, and a brief description of the CBI. The process for modifying a record is similar to adding a record, with the exception that all information in the record that is being modified appears on the entry screen.

After the user is satisfied that all information for the contribution has been entered properly, a *send* button is clicked and an encoded message representing the entry is placed in a holding pen waiting for the next connect with the the hub. Message for resource entry received at the hub are compiled in an *Evaluator's Stack* and reviewed for content and accuracy. Once approved, a *change resource* system message is sent to the remote stations where the approved entry is appended to the appropriate resource. A *change catalog* system message can also be issued from the hub to delete records.

By using this approach, contributions to resources on the hard drives can be made by any user on the UNITE system, in other words, they are community publications by the users. These resources are also dynamic in the sense that they are going through metamorphoses as influenced by both user contributions and usage patterns. Because these community-published dynamic resources reside on the hard drives of the user's computer, they also operate much faster and include graphical interfaces that are not available when viewing interfaces to long distance networks that are reading data directly from a host computer. The community-published dynamic resources that have been developed thus far include: the CBI catalog, a Lesson Plan catalog, Field Trips, and an index of abstracts from educational research/method articles.

We see many promising possibilities for these community-published dynamic resources. There is the prospect of dynamically constructing catalogs of exemplary Lesson Plans produced by teachers from throughout the country or world. We now have the ability to quickly disseminate resources dealing with timely topics such as drug or AIDS education in a consistent format. Perhaps the most important implication may have to do with the positive social and psychological impact that community-published dynamic resources could have on educators. By contributing to these resources, the user becomes an active participant in technological innovation not simply a passive bystander caught in waves of information and technological overload. Collaboration and cooperation among educators who have common goals might also be enhanced as they mutually contribute to the development of community-published dynamic resources.

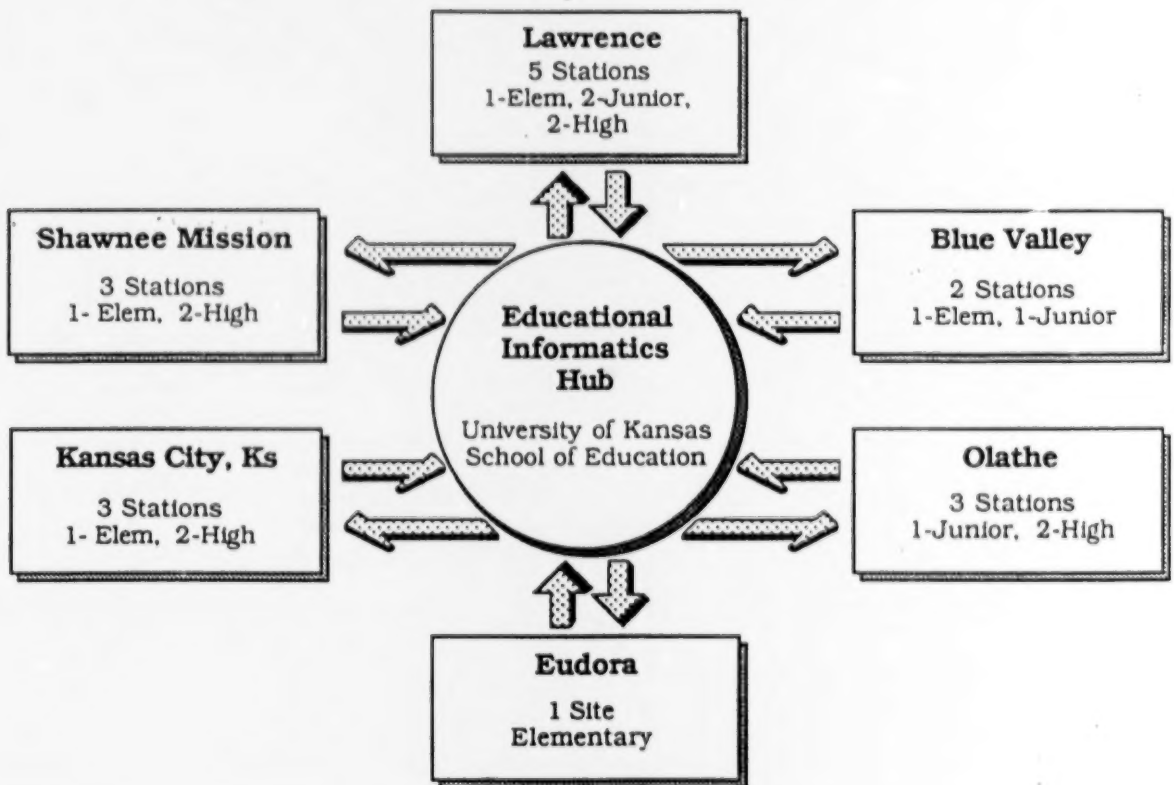
Developing global participation

As we approach the 21st century, more effective means for navigating through the ever expanding seas of information are needed. Computers appear to be the tools of the information age and as Ted Nelson prophesied, "If computers are the wave of the future then displays are the surfboards." Icons and graphical interfaces are clear contributions to presenting information about processes and relationships in a concise manner. But much remains to be done before their potential will be realized. Standards will need to be established in such areas as: the use of windows, pull-down menus, animation for transitions between information resources, hierarchies for organizing information and universally understood icons that cross language barriers.

To meet this challenge, formative evaluation should be conducted across great distances and in a short amount of time so that strategies can be developed prior to the next wave. Electronic networks may serve as useful tools both for gathering evaluations and conducting rapid modifications to systems designed for organizing and managing information. These development strategies must also consider the social and psychological impact of adjusting to the Information Age. One possible remedy is to provide community-published resources that are relevant to user needs and allow educators to participate in the innovations of the 21st Century.

Figure 1

Schools who participated in the UNITE project



The 17 stations were selected on the basis of previous and projected clinical experience placements with consideration for equivalent grade level and minority representations. Each station includes: 1 Macintosh SE™ 20Meg hard drive, 1 Apple Modem and 1 ImageWriter II™.

Figure 2

UNITE Resource Navigation System



Content categories are located vertically along the left margin of the screen and the four support categories, *Administration*, *Courseware*, *Teaching* and *Research* are located along horizontally along the the bottom of the UNITE resource navigator. In this view the user began by selecting the support category for *Courseware*. The main content category *Natural Science* and then the sub-categories of *Life Science* and *Ecology* were selected. The user has just selected the software the software *Oh Deer* which is an ecological simulation of an overpopulated deer heard. The Δ IIe that precedes the courseware name indicates that the *Oh Deer* CBI is for an Apple IIe computer, that it is available in at least one of the participating schools and that there is an entry for *Oh Deer* in the UNITE catalog of courseware. Having clicked on the *Oh Deer* courseware the user will be taken directly to the catalog entry depicted in Figure 3.

Figure 3

A UNITE screen showing an entry for the *Oh Deer*
Computer-Based Instruction Catalog

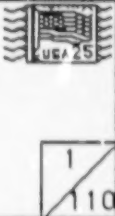
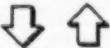
Subject: Natural Science Life Science Ecology Alle Oh Deer	 Oh Deer		
Grade Level: Grades 6-8 ++	GENERAL DESCRIPTION:		
Equipment Needs: Apple IIplus ++	☒ Apple IIplus ☒ Apple IIe ☒ Apple GS ☐ Macintosh Plus ☐ Macintosh SE ☐ CD-ROM ☐ VideoDisc Player ☐ PC/compatible	simulation which depicts The computer user is utilize the deer population d information is available agement methods. After ment method, the the decrease or increase for the first year. The ment methods for the other so displayed.	
Libraries: UNITE Hub Olathe North	Close		
Author: Innovative	1. Demonstrates the relationship between		
Rating: 83	Admin.	Courseware	Teaching
  	Research		

This screen makes available all basic information related to a piece of courseware. The scrolling field in the background contains a description of the courseware and suggestions for its use. The buttons in the left margin are pop up displays of detailed information. The user is currently viewing the *equipment needs* for *Oh Deer*.

The format of the catalog of lesson plans is also similar to this screen with the following information available through the buttons in the left margin: subject, activities, intended learners, objectives, resources and author. The research catalog includes: title, reference, subject, descriptors, abstract, reviewers and libraries.

Figure 4

A UNITE Messaging System

Case OLATHE SOUTH 11/3/89 10:58 AM		to: Martin copies to: Natural Science subject: Info On the Prairie Center!!!!				
I am the person to contact for Prairie Center information. I am also a very hard person to get hold of. I live at the center and often when I am home I am outside and not around a phone. A couple of general things until we can talk. The phone number is incorrect. The Prairie center number is 1- 884-8832 (which is where you can reach me) and this is where people can call for information or to set up visit dates. We have activities K-12 for the center. The high school activities are biology/ecology activities although we want to develop activities in						
						

This actual message was sent over the network on November 3, 1989. The upper right corner shows a cancelled stamp indicating that the message has been mailed. Directly below the stamp are numbers showing that this is message 1 of 110. From left to right along the bottom of the screen are:

1. the button that returns the user to the Resource Navigator;
2. the button for writing a message;
3. the mail list button;
4. the arrow button for going to the next message
5. the arrow button for going to the previous message;
6. the button that shows additional information about the users, including: the content and grade level they teach, where they teach and their special interest groups;
7. the trash can button for throwing away messages;
8. the printer button .

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